Great North Road Solar and Biodiversity Park

Environmental Statement

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Technical Appendix A8.14 – Electromagnetic Fields and Fish

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Contents

A8.14.1 INTRODUCTION

1 This technical note has been prepared in response to address a consultation comment from the Environment Agency (EA) concerning the impact of Electromagnetic Fields (EMF) on fish species:

2 *"Electro Magnetic Fields Mitigation*

3 *(Chapter 8 Ecology and Biodiversity, Section: 8.8.11.4)*

4 *Issue*

5 *Insufficient evidence behind proposed mitigation for effects of Electro Magnetic Fields (EMF).*

6 *Impact*

7 *Protected fish species may be impacted by EMFs.*

8 *Solution*

9 *Whilst we agree that depth and insulation of cables can mitigate the effects of EMFs on fish. Evidence should present that a depth of 5m will reduce the impact of EMF on fish to negligible levels. Providing an assessment and quantification of the strength of EMF levels at bed of the watercourse at 5m depth would be useful. Furthermore, clear details of watercourse and cable crossing locations, and details of fish present, will help understand the level of risk."*

10 This technical note provides evidence to support the assessment and mitigation of effects to fish from EMF.

A8.14.2 CONTEXT

11 Electric transmission cables have the potential to produce both electric and magnetic fields in marine environments[1]. Together, these fields are known as electromagnetic fields (EMFs) and they can be detected by a variety of marine species[2]. Underground cables eliminate the electric field because as it is screened out by the sheath around the cable, but they still produce magnetic fields. Nonethless, the term EMF will be used to describe the magnetic fields emitted by underground cables.

12 The Development includes underground cabling of the following specifications:

- 11 kV Medium Voltage (MV) cables connecting the solar PV areas to intermediate substations;
- 33 kV Medium Voltage (MV) cables connecting the solar PV areas to intermediate substations;
- 132 kV High Voltage (HV) cables connecting intermediate substations to the 400 kV substation; and
- 400 kV Extra High Voltage (EHV) cable connecting the 400 kV substation to the National Grid Staythorpe substation.

[1] Gill, A. B. and Bartlett, M. D. (2010). Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel. Scottish Natural Heritage Commissioned Report No. 401.

13 These cables will be buried at depth of 0.6–1.5 m throughout most of the Development. The cables will also cross a variety of small watercourses and these crossings will be achieved by either open cut trenching or by Horizontal Directional Drilling (HDD), both of which will result in the cable being buried beneath the channel bed.

14 Based on the results of the ecological desk study (reported in Technical Appendix A8.9 of the ES [EN010162/APP/6.4.8.9]), the watercourses associated with the Development have the potential to support a range of freshwater fish species, including: brown trout, bullhead, European eel, river lamprey, sea lamprey and spined loach. European eel is recognised as being sensitive to EMF, whereas there is a lack of robust evidence for most other species.

15 There are a variety of watercourses associated with the Development, many of which are direct tributaries (or in the catchment) of the River Trent to the east. The few large, permanent watercourses – The Beck, Pingley Dyke and Moorhouse Beck – have the greatest potential to support fish and it is from these watercourses that the desk study records were returned.

A8.14.2.1 POTENTIAL ECOLOGICAL EFFECTS

16 Electromagnetic fields occur naturally, providing important ecological cues to species throughout their life cycles[2]. The background level of geomagnetic EMF is 50 μT[3]. Anthropogenic changes to the EMF environment, therefore, have the potential to change the behaviour of sensitive species.

17 Much of the available research about the effects of EMF on fish is based on studies of individual animal responses in the marine environment, including on the marine life-stages of catadromous and anadromous migratory species, although population level effects appear to be poorly understood[4,5,6]. Nonetheless, it is reasonable to make inferences from this research to the freshwater environment, perhaps especially for catadromous and anadromous species (i.e., European eel, river lamprey and sea lamprey) which may use the freshwater habitats associated with the Development.

A8.14.2.2 DESIGN CONSIDERATIONS

18 National Policy Statements (NPS) outline planning policy relating to electricity infrastructure:

- Overarching NPS for Energy (EN-1)[7];

[2] Hutchison, Z. L. et al. (2021). A modelling evaluation of electromagnetic fields emitted by buried subsea power cables and encountered by marine animals: Considerations for marine renewable energy development. Renewable Energy 177: 72–81.
[3] Energy Networks Association (2012) Electric and Magnetic Fields.
[4] Copping, A. E. et al. (2020). Potential environmental effects of marine renewable energy development – the state of the science. Journal of Marine Science and Engineering 8(11).
[5] Taormina, B. et al. (2018). A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. Renewable and Sustainable Energy Reviews 96: 380–391.
[6] Hutchison, Z. L. et al. (2020). The interaction between resource species and electromagnetic fields associated with electricity production by offshore wind farms. Oceanography 33(4): 96–107
[7] Gov.UK (2023). Overarching National Policy Statement for energy (EN-1) (Updated 17 January 2024). Available at: https://www.gov.uk/government/publications/overarching-national-policy-statement-for-energy-en-1/overarching-national-policy-statement-for-energy-en-1

- NPS for Renewable Energy Infrastructure (EN-3)[8]; and
- NPS for Electricity Networks Infrastructure (EN-5)[9].

19 In relation to the offshore/marine environment, paragraphs 2.8.264–247 of EN-3 include the following:

20 *"2.8.245 EMF in the water column during operation, is in the form of electric and magnetic fields, which are reduced by use of armoured cables for interarray and export cables10.*

21 *2.8.246 Burial of the cable increases the physical distance between the maximum EMF intensity and sensitive species. However, what constitutes sufficient depth to reduce impact may depend on the geology of the seabed.*

22 *2.8.247 It is unknown whether exposure to multiple cables and larger capacity cables may have a cumulative impact on sensitive species."*

23 These statements suggest that armouring/insulating and burying cables are the two principal methods of mitigating the potential effects of EMF and both have been incorporated into the Development design.

A8.14.3 POTENTIAL EFFECTS

A8.14.3.1 EMF FROM CABLES

24 A study by National Grid study[11] reports EMF values at different distances from a 400 kV cable direct buried to a depth of 1.0 m and with 0.5 m spacing between cables. The relationship between EMF and distance from cable is inversely proportional (Inset A8.14.1), demonstrating that EMF rapidly attenuates with distance. The EMF expected at 5 m from the cable centreline is 3 μT (Table A8.14.1).

25 The cable specification (e.g.; sheathing and insulating properties) for the development will follow prevailing guidance and so align closely with the National Grid values. The values presented are for the 400 kV/EHV cable and so present the worst-case scenario. HV and MV cables will emit smaller, less powerful fields.

[8] Gov.UK (2024). National Policy Statement for renewable energy infrastructure (EN-3) (Updated 17 January 2024). Available at: https://www.gov.uk/government/publications/national-policy-statement-for-renewable-energy-infrastructure-en-3/national-policy-statement-for-renewable-energy-infrastructure-en-3
[9] GOV.UK. (2024). National Policy Statement for electricity networks infrastructure (EN-5) (Updated 17 January 2024). Available at: https://www.gov.uk/government/publications/national-policy-statement-for-electricity-networks-infrastructure-en-5/national-policy-statement-for-electricity-networks-infrastructure-en-5
[10] The voltage of the cables are typically in the range of the HV to EHV cables for the Development
[11] National Grid (2015). Undergrounding high voltage electricity transmission lines. The technical issues.

***Inset A8.14.1: EMF levels (μT) at distance from a buried 400 kV cable** [taken from National Grid (2015[11])*

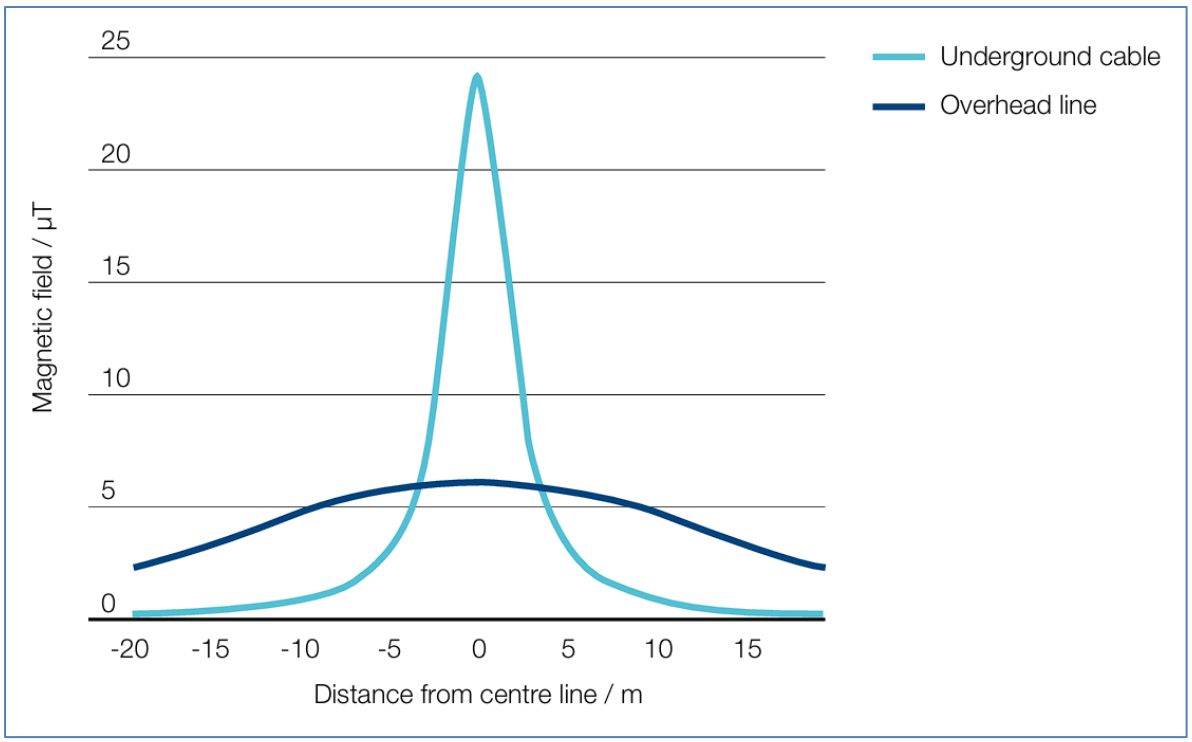

Table A8.14.1: EMF levels (μT) at defined distances from a buried 400 kV cable

Value	0 m from centreline	5 m from centreline
Max	96	13
Typical	24	3

A8.14.3.2 BIOLOGICAL RESPONSES

26 European eel is recognised to be sensitive to EMF and is one of the better studied fish species in this respect. In the absence of research for other fish species, the responses of European eel can be used as a model for other fish species.

27 Laboratory research has shown that that European eels respond to EMF in the range of 40–50 μT[12,13]. In another study, replicating potential responses to the EMF from subsea cables, eels exposed to a field intensity of approximately 9.6 μT showed no significant differences in a range of behaviours compared to controls[14].

28 These observed responses, or lack thereof, are at thresholds that the cables of the Development are extremely unlikely to exceed. Furthermore, the likely

[12] Durif, C. M. F. et al. (2013). Magnetic compass orientation in the European eel. PLoS ONE 8(3).
[13] Naissbett-Jones *et al*. (2017). A magnetic map leads juvenile European eels to the Gulf Stream. Current Biology 27(8) 1236–1240
[14] Orpwood *et al*. (2015). Effects of AC Magnetic Fields (MFs) on Swimming Activity in European Eels Anguilla anguilla. Scottish Marine and Freshwater Science 6(8)

EMF from the cables is well within the background geomagnetic level of EMF.

A8.14.4 SUMMARY

29 The Development design includes embedded mitigation that will avoid adverse ecological effects of EMF from underground cables. The specification of the different cables for the Development will be determined by the detailed design following consent. The specification will include the insulation and depth to which the cables will be buried such that in-channel exposure to EMF will not exceed thresholds likely to cause behavioural responses in fish.